

#4



SEQUENCE LISTING

<110> ZHU, JIAN-KANG

LIU, JIPING

ISHITANI, MANABU

HALFTER, URSULA

KIM, CHEOL-SOO

<120> PROTEINS AND DNA RELATED TO SALT TOLERANCE IN PLANTS

<130> 205645US20

<140> 09/824,735

<141> 2001-04-04

<150> US 60/824,735

<151> 2000-04-04

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<170> PatentIn version 3.1

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| gct aag agt aca ata ctt aag aac aga atg gtt gat cag gtatgttctg Ala Lys Ser Thr Ile Leu Lys Asn Arg Met Val Asp Gln 45 | 50 | 55 | 2178 | | |
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| cac ccg aac ata gtg agg ttg tat gag gtatgtttgt ttgtttccat His Pro Asn Ile Val Arg Leu Tyr Glu 70 | | | 75 | 2290 | |
| gcatactgcga aattttatct ctgaagtgtt tttgcacatcat tgttcttctg ttgtttttt gatttcc cgatgttag gtg ttg gcg agt cct tcg aaa ata tat ata gtt Val Leu Ala Ser Pro Ser Lys Ile Tyr Ile Val 80 | | | 85 | 2337 | |
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| ccatacttg taggcagcgt ccatttagtta aaacctctct acttaatttt ttaatatatg aatctttca tgca gtt cat aaa ggg agg ctt gaa gaa agt gag tct cgg Val His Lys Gly Arg Leu Glu Ser Glu Ser Arg 105 | | | 110 | 2448 | |
| aaa tac ttt caa cag ctt gta gat gct gtt gct cat tgt cac tgc aag Lys Tyr Phe Gln Gln Leu Val Asp Ala Val Ala His Cys His Cys Lys 115 | | | 120 | 125 | 2497 |
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| ggg gtt att ctt ttc gtt ata ttg gct gga tat tta cct ttt tcc gag Gly Val Ile Leu Phe Val Ile Leu Ala Gly Tyr Leu Pro Phe Ser Glu 200 205 210 | 3073 |
| acg gat ctt cca ggg ttg tac aga aaa gtaagtaaca tatctttcgg Thr Asp Leu Pro Gly Leu Tyr Arg Lys 215 220 | 3120 |
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| aatttcaccc ttagtttga gctttacac attgttattt acag ata aat gca gca Ile Asn Ala Ala 225 | 3236 |
| gag ttt tct tgt cca ccg tgg ttt tcc gca gaa gtg aag ttt tta ata Glu Phe Ser Cys Pro Pro Trp Phe Ser Ala Glu Val Lys Phe Leu Ile 230 235 240 | 3284 |
| cat agg ata ctt gac ccc aat ccc aaa aca gtgagttt tgctttgttc His Arg Ile Leu Asp Pro Asn Pro Lys Thr 245 250 | 3334 |
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| gaa gtg aat ttg gat gat att cgt gca gtt ttt gat gga att gag Glu Val Asn Leu Asp Asp Ile Arg Ala Val Phe Asp Gly Ile Glu 280 285 290 | 3540 |
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| aggcatgtgt tagttaccaa acctgtaaac tgcttcttta ttcaattcgc caaaccatag 31 | 3720 |
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| gcataatgg aatgtttac tttaactcag gctcttgctc ttctaaaact tgtacttcaa | 3960 |
| ttgttaaact aaaacccatcg tatctgtctt agctaaagtt actttactt gttttcatt | 4020 |
| aagttgacct gtcaattgca cttgttcaca g ggc agt tat gta gcg gag aat Gly Ser Tyr Val Ala Glu Asn | 4072 |
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| gta gag aga aat gat gaa ggg ccc ctg atg atg aat gcc ttt gag atg Val Glu Arg Asn Asp Glu Gly Pro Leu Met Met Asn Ala Phe Glu Met | 4120 |
| 300 305 310 315 | |
| att acc tta tca caa ggc tta aat tta tct gca cta ttt gac agg cga Ile Thr Leu Ser Gln Gly Leu Asn Leu Ser Ala Leu Phe Asp Arg Arg | 4168 |
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| aaagaatgtcg gtagcatcta ttcttcagac tgcccgaaaa gactgcctta tgatgctgtg | 4281 |
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| atacaaatgg aatccaaaat gttcctgcatt attgatggct gatccttga tctcgcag | 4399 |
| gat ttt gtt aaa agg caa acc cgt ttt gtt tct cga agg gaa cct agt Asp Phe Val Lys Arg Gln Thr Arg Phe Val Ser Arg Arg Glu Pro Ser | 4447 |
| 335 340 345 | |
| gag ata att gct aac att gag gct gta gcg aac tca atg ggt ttt aag Glu Ile Ile Ala Asn Ile Glu Ala Val Ala Asn Ser Met Gly Phe Lys | 4495 |
| 350 355 360 | |
| tct cat aca cga aac ttc aag gtaacgaatt cctagcatat tacacttac | 4546 |
| Ser His Thr Arg Asn Phe Lys | |
| 365 370 | |
| acagagatta tgcattattt taaaactctc aactgttaaa cgcatgtgta gatagattga | 4606 |
| taagattgac aaggaaactt agtttatatc tctggcggttc aaaaacgaaa gtccttagtgt | 4666 |
| gaattatcat tttaatgtt agcagagagt acaattgtt tgatttgtt cgtctatgtg | 4726 |
| ctcaacag aca agg ctc gag gga tta tct tcg atc aag gcc gga cag tta Thr Arg Leu Glu Gly Leu Ser Ser Ile Lys Ala Gly Gln Leu | 4776 |
| 375 380 385 | |

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| gcttcagttt aagggtatct agcaaattga aattaaccta catgcag att tac gag | 4887 |
| Ile Tyr Glu | |
| gtg gca cca tcg ctt ttc atg gta gac gta aga aag gct gct ggt gaa | 4935 |
| Val Ala Pro Ser Leu Phe Met Val Asp Val Arg Lys Ala Ala Gly Glu | |
| 395 400 405 | |
| act ctt gaa tat cac aag gtttataaat atatatccaa taacaatagt | 4983 |
| Thr Leu Glu Tyr His Lys | |
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| tgc catcatta ctgtgttgcg gatttagagtg atattttgtt ttgtggtatac gcag ttc | 5040 |
| tgc | Phe |
| tac aag aag cta tgt tcg aaa ctg gaa aac ata ata tgg agg gca aca | 5088 |
| Tyr Lys Lys Leu Cys Ser Lys Leu Glu Asn Ile Ile Trp Arg Ala Thr | |
| 420 425 430 | |
| gaa gga ata cca aag tca gag att ctc aga aca atc acg ttt | 5130 |
| Glu Gly Ile Pro Lys Ser Glu Ile Leu Arg Thr Ile Thr Phe | |
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| Thr Gly Asp Asn Val Ala Ile Lys Ile Met Ala Lys Ser Thr Ile Leu | |

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Lys Asn Arg Met Val Asp Gln Ile Lys Arg Glu Ile Ser Ile Met Lys
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Ile Val Arg His Pro Asn Ile Val Arg Leu Tyr Glu Val Leu Ala Ser
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Pro Ser Lys Ile Tyr Ile Val Leu Glu Phe Val Thr Gly Gly Glu Leu
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Phe Asp Arg Ile Val His Lys Gly Arg Leu Glu Glu Ser Glu Ser Arg
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Lys Tyr Phe Gln Gln Leu Val Asp Ala Val Ala His Cys His Cys Lys
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Gly Val Tyr His Arg Asp Leu Lys Pro Glu Asn Leu Leu Leu Asp Thr
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Asn Gly Asn Leu Lys Val Ser Asp Phe Gly Leu Ser Ala Leu Pro Gln
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Glu Gly Val Glu Leu Leu Arg Thr Thr Cys Gly Thr Pro Asn Tyr Val
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Ile Trp Ser Cys Gly Val Ile Leu Phe Val Ile Leu Ala Gly Tyr Leu
 195 200 205

Pro Phe Ser Glu Thr Asp Leu Pro Gly Leu Tyr Arg Lys Ile Asn Ala
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Ala Glu Phe Ser Cys Pro Pro Trp Phe Ser Ala Glu Val Lys Phe Leu
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Ile His Arg Ile Leu Asp Pro Asn Pro Lys Thr Arg Ile Gln Ile Gln

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Gly Ile Lys Lys Asp Pro Trp Phe Arg Leu Asn Tyr Val Pro Ile Arg
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Ala Arg Glu Glu Glu Val Asn Leu Asp Asp Ile Arg Ala Val Phe
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Asp Gly Ile Glu Gly Ser Tyr Val Ala Glu Asn Val Glu Arg Asn Asp
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Glu Gly Pro Leu Met Met Asn Ala Phe Glu Met Ile Thr Leu Ser Gln
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Gly Leu Asn Leu Ser Ala Leu Phe Asp Arg Arg Gln Asp Phe Val Lys
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Arg Gln Thr Arg Phe Val Ser Arg Arg Glu Pro Ser Glu Ile Ile Ala
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Asn Ile Glu Ala Val Ala Asn Ser Met Gly Phe Lys Ser His Thr Arg
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Asn Phe Lys Thr Arg Leu Glu Gly Leu Ser Ser Ile Lys Ala Gly Gln
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Leu Ala Val Val Ile Glu Ile Tyr Glu Val Ala Pro Ser Leu Phe Met
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Val Asp Val Arg Lys Ala Ala Gly Glu Thr Leu Glu Tyr His Lys Phe
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Gly Ala His Ile Gly Asn Tyr Gln Ile Val Lys Thr Leu Gly Glu Gly
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Ser Phe Gly Lys Val Lys Leu Ala Tyr His Thr Thr Thr Gly Gln Lys
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Gln Gly Arg Ile Glu Arg Glu Ile Ser Tyr Leu Arg Leu Leu Arg His
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Pro His Ile Ile Lys Leu Tyr Asp Val Ile Lys Ser Lys Asp Glu Ile
115 120 125

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Gln Arg Asp Lys Met Ser Glu Gln Glu Ala Arg Arg Phe Phe Gln Gln
145 150 155 160

Ile Ile Ser Ala Val Glu Tyr Cys His Arg His Lys Ile Val His Arg
165 170 175

Asp Leu Lys Pro Glu Asn Leu Leu Asp Glu His Leu Asn Val Lys
180 185 190

Ile Ala Asp Phe Gly Leu Ser Asn Ile Met Thr Asp Gly Asn Phe Leu
195 200 205

Lys Thr Ser Cys Gly Ser Pro Asn Tyr Ala Ala Pro Glu Val Ile Ser
210 215 220

Gly Lys Leu Tyr Ala Gly Pro Glu Val Asp Val Trp Ser Cys Gly Val
225 230 235 240

Ile Leu Tyr Val Met Leu Cys Arg Arg Leu Pro Phe Asp Asp Glu Ser
245 250 255

Ile Pro Val Leu Phe Lys Asn Ile Ser Asn Gly Val Tyr Thr Leu Pro
260 265 270

Lys Phe Leu Ser Pro Gly Ala Ala Gly Leu Ile Lys Arg Met Leu Ile
275 280 285

Val Asn Pro Leu Asn Arg Ile Ser Ile His Glu Ile Met Gln Asp Asp
290 295 300

Trp Phe Lys Val Asp Leu Pro Glu Tyr Leu Leu Pro Pro Asp Leu Lys
305 310 315 320

Pro His Pro Glu Glu Asn Glu Asn Asn Asp Ser Lys Lys Asp Gly
325 330 335

Ser Ser Pro Asp Asn Asp Glu Ile Asp Asp Asn Leu Val Asn Ile Leu
340 345 350

Ser Ser Thr Met Gly Tyr Glu Lys Asp Glu Ile Tyr Glu Ser Leu Glu
355 360 365

Ser Ser Glu Asp Thr Pro Ala Phe Asn Glu Ile Arg Asp Ala Tyr Met
370 375 380

Leu Ile Lys Glu Asn Lys Ser Leu Ile Lys Asp Met Lys Ala Asn Lys
385 390 395 400

Ser Val Ser Asp Glu Leu Asp Thr Phe Leu Ser Gln Ser Pro Pro Thr
405 410 415

Phe Gln Gln Gln Ser Lys Ser His Gln Lys Ser Gln Val Asp His Glu
420 425 430

Thr Ala Lys Gln His Ala Arg Arg Met Ala Ser Ala Ile Thr Gln Gln
435 440 445

Arg Thr Tyr His Gln Ser Pro Phe Met Asp Gln Tyr Lys Glu Glu Asp
450 455 460

Ser Thr Val Ser Ile Leu Pro Thr Ser Leu Pro Gln Ile His Arg Ala
465 470 475 480

Asn Met Leu Ala Gln Gly Ser Pro Ala Ala Ser Lys Ile Ser Pro Leu
485 490 495

Val Thr Lys Lys Ser Lys Thr Arg Trp His Phe Gly Ile Arg Ser Arg
500 505 510

Ser Tyr Pro Leu Asp Val Met Gly Glu Ile Tyr Ile Ala Leu Lys Asn
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Leu Gly Ala Glu Trp Ala Lys Pro Ser Glu Glu Asp Leu Trp Thr Ile
530 535 540

Lys Leu Arg Trp Lys Tyr Asp Ile Gly Asn Lys Thr Asn Thr Asn Glu
545 550 555 560

Lys Ile Pro Asp Leu Met Lys Met Val Ile Gln Leu Phe Gln Ile Glu
565 570 575

Thr Asn Asn Tyr Leu Val Asp Phe Lys Phe Asp Gly Trp Glu Ser Ser
580 585 590

Tyr Gly Asp Asp Thr Thr Val Ser Asn Ile Ser Glu Asp Glu Met Ser
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Thr Phe Ser Ala Tyr Pro Phe Leu His Leu Thr Thr Lys Leu Ile Met
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Glu Leu Ala Val Asn Ser Gln Ser Asn
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<212> PRT

<213> Homo sapiens

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35 40 45

Arg Gln Lys Ile Arg Ser Leu Asp Val Val Gly Lys Ile Lys Arg Glu
50 55 60

Ile Gln Asn Leu Lys Leu Phe Arg His Pro His Ile Ile Lys Leu Tyr
65 70 75 80

Gln Val Ile Ser Thr Pro Thr Asp Phe Phe Met Val Met Glu Tyr Val
85 90 95

Ser Gly Gly Glu Leu Phe Asp Tyr Ile Cys Lys His Gly Arg Val Glu
100 105 110

Glu Met Glu Ala Arg Arg Leu Phe Gln Gln Ile Leu Ser Ala Val Asp
115 120 125

Tyr Cys His Arg His Met Val Val His Arg Asp Leu Lys Pro Glu Asn
130 135 140

Val Leu Leu Asp Ala His Met Asn Ala Lys Ile Ala Asp Phe Gly Leu
145 150 155 160

Ser Asn Met Met Ser Asp Gly Glu Phe Leu Arg Thr Ser Cys Gly Ser
165 170 175

Pro Asn Tyr Ala Ala Pro Glu Val Ile Ser Gly Arg Leu Tyr Ala Gly
180 185 190

Pro Glu Val Asp Ile Trp Ser Cys Gly Val Ile Leu Tyr Ala Leu Leu
195 200 205

Cys Gly Thr Leu Pro Phe Asp Asp Glu His Val Pro Thr Leu Phe Lys
210 215 220

Lys Ile Arg Gly Gly Val Phe Tyr Ile Pro Glu Tyr Leu Asn Arg Ser
225 230 235 240

Val Ala Thr Leu Leu Met His Met Leu Gln Val Asp Pro Leu Lys Arg
245 250 255

Ala Thr Ile Lys Asp Ile Arg Glu His Glu Trp Phe Lys Gln Gly Leu
260 265 270

Pro Ser Tyr Leu Phe Pro Glu Asp Pro Ser Tyr Asp Ala Asn Val Ile
275 280 285

Asp Asp Glu Ala Val Lys Glu Val Cys Glu Lys Phe Glu Cys Thr Glu
290 295 300

Ser Glu Val Met Asn Ser Leu Tyr Ser Gly Asp Pro Gln Asp Gln Leu
305 310 315 320

Ala Val Ala Tyr His Leu Ile Ile Asp Asn Arg Arg Ile Met Asn Gln
325 330 335

Ala Ser Glu Phe Tyr Leu Ala Ser Ser Pro Pro Ser Gly Ser Phe Met
340 345 350

Asp Asp Ser Ala Met His Ile Pro Pro Gly Leu Lys Pro His Pro Glu
355 360 365

Arg Met Pro Pro Leu Ile Ala Asp Ser Pro Lys Ala Arg Cys Pro Leu
370 375 380

Asp Ala Leu Asn Thr Thr Lys Pro Lys Ser Leu Ala Val Lys Lys Ala
385 390 395 400

Lys Trp His Leu Gly Ile Arg Ser Gln Ser Lys Pro Tyr Asp Ile Met
405 410 415

Ala Glu Val Tyr Arg Ala Met Lys Gln Leu Asp Phe Glu Trp Lys Val
420 425 430

Val Asn Ala Tyr His Leu Arg Val Arg Arg Lys Asn Pro Val Thr Gly
435 440 445

Asn Tyr Val Lys Met Ser Leu Gln Leu Tyr Leu Val Asp Asn Arg Ser
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Tyr Leu Leu Asp Phe Lys Ser Ile Asp Asp Glu Val Val Glu Gln Arg
465 470 475 480

Ser Gly Ser Ser Thr Pro Gln Arg Ser Cys Ser Ala Ala Gly Leu His
485 490 495

Arg Pro Arg Ser Ser Phe Asp Ser Thr Thr Ala Glu Ser His Ser Leu
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Ser Gly Ser Leu Thr Gly Ser Leu Thr Gly Ser Thr Leu Ser Ser Val
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Ser Leu Ile Thr Thr Leu Ala Arg
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<213> Schizosaccharomyces pombe

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Lys Ile Tyr Ala Val Lys Phe Val Asn Lys Lys His Ala Thr Ser Cys
35 40 45

Met Asn Ala Gly Val Trp Ala Arg Arg Met Ala Ser Glu Ile Gln Leu
50 55 60

His Lys Leu Cys Asn Gly His Lys Asn Ile Ile His Phe Tyr Asn Thr
65 70 75 80

Ala Glu Asn Pro Gln Trp Arg Trp Val Val Leu Glu Phe Ala Gln Gly
85 90 95

Gly Asp Leu Phe Asp Lys Ile Glu Pro Asp Val Gly Ile Asp Glu Asp
100 105 110

Val Ala Gln Phe Tyr Phe Ala Gln Leu Met Glu Gly Ile Ser Phe Met
115 120 125

His Ser Lys Gly Val Ala His Arg Asp Leu Lys Pro Glu Asn Ile Leu
130 135 140

Leu Asp Tyr Asn Gly Asn Leu Lys Ile Ser Asp Phe Gly Phe Ala Ser
145 150 155 160

Leu Phe Ser Tyr Lys Gly Lys Ser Arg Leu Leu Asn Ser Pro Val Gly
165 170 175

Ser Pro Pro Tyr Ala Ala Pro Glu Ile Thr Gln Gln Tyr Asp Gly Ser
180 185 190

Lys Val Asp Val Trp Ser Cys Gly Ile Ile Leu Phe Ala Leu Leu Leu
195 200 205

Gly Asn Thr Pro Trp Asp Glu Ala Ile Ser Asn Thr Gly Asp Tyr Leu
210 215 220

Leu Tyr Lys Lys Gln Cys Glu Arg Pro Ser Tyr His Pro Trp Asn Leu
225 230 235 240

Ileu Ser Pro Gly Ala Tyr Ser Ile Ile Thr Gly Met Leu Arg Ser Asp
245 250 255

Pro Phe Lys Arg Tyr Ser Val Lys His Val Val Gln His Pro Trp Leu
260 265 270

Thr Ser Ser Thr Pro Phe Arg Thr Lys Asn Gly Asn Cys Ala Asp Pro
275 280 285

Val Ala Leu Ala Ser Arg Leu Met Leu Lys Leu Arg Ile Asp Leu Asp
290 295 300

Lys Pro Arg Leu Ala Ser Ser Arg Ala Ser Gln Asn Asp Ser Gly Phe
305 310 315 320

Ser Met Thr Gln Pro Ala Phe Lys Lys Asn Asp Gln Lys Glu Leu Asp
325 330 335

Arg Val Glu Val Tyr Gly Ala Leu Ser Gln Pro Val Gln Leu Asn Lys
340 345 350

Asn Ile Asp Val Thr Glu Ile Leu Glu Lys Asp Pro Ser Leu Ser Gln
355 360 365

Phe Cys Glu Asn Glu Gly Phe Ile Lys Arg Leu Ala Lys Lys Ala Lys
370 375 380

Asn Phe Tyr Glu Ile Cys Pro Pro Glu Arg Leu Thr Arg Phe Tyr Ser
385 390 395 400

Arg Ala Ser Arg Glu Thr Ile Ile Asp His Leu Tyr Asp Ser Leu Arg
405 410 415

Leu Leu Ala Ile Ser Val Thr Met Lys Tyr Val Arg Asn Gln Thr Ile
420 425 430

Leu Tyr Val Asn Leu His Asp Lys Arg Lys Cys Leu Leu Gln Gly Val
435 440 445

Ile Glu Leu Thr Asn Leu Gly His Asn Leu Glu Leu Ile Asn Phe Ile
450 455 460

Lys Arg Asn Gly Asp Pro Leu Glu Trp Arg Lys Phe Phe Lys Asn Val
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Val Ser Ser Ile Gly Lys Pro Ile Val Leu Thr Asp Val Ser Gln Asn
485 490 495

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<212> PRT

<213> Homo sapiens

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35 40 45

Pro Glu Asn Ile Lys Lys Glu Ile Cys Ile Asn Lys Met Leu Asn His
50 55 60

Glu Asn Val Val Lys Phe Tyr Gly His Arg Arg Glu Gly Asn Ile Gln
65 70 75 80

Tyr Leu Phe Leu Glu Tyr Cys Ser Gly Gly Glu Leu Phe Asp Arg Ile
85 90 95

Glu Pro Asp Ile Gly Met Pro Glu Pro Asp Ala Gln Arg Phe Phe His
100 105 110

Gln Leu Met Ala Gly Val Val Tyr Leu His Gly Ile Gly Ile Thr His
115 120 125

Arg Asp Ile Lys Pro Glu Asn Leu Leu Asp Glu Arg Asp Asn Leu
130 135 140

Lys Ile Ser Asp Phe Gly Leu Ala Thr Val Phe Arg Tyr Asn Asn Arg
145 150 155 160

Glu Arg Leu Leu Asn Lys Met Cys Gly Thr Leu Pro Tyr Val Ala Pro
165 170 175

Glu Leu Leu Lys Arg Arg Glu Phe His Ala Glu Pro Val Asp Val Trp
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Ser Cys Gly Ile Val Leu Thr Ala Met Leu Ala Gly Glu Leu Pro Trp
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Asp Gln Pro Ser Asp Ser Cys Gln Glu Tyr Ser Asp Trp Lys Glu Lys
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Lys Thr Tyr Leu Asn Pro Trp Lys Lys Ile Asp Ser Ala Pro Leu Ala
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Leu Leu His Lys Ile Leu Val Glu Asn Pro Ser Ala Arg Ile Thr Ile
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Pro Asp Ile Lys Lys Asp Arg Trp Tyr Asn Lys Pro Leu Lys Lys Gly
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Ala Lys Arg Pro Arg Val Thr Ser Gly Gly Val Ser Glu Ser Pro Ser
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Gly Phe Ser Lys His Ile Gln Ser Asn Leu Asp Phe Ser Pro Val Asn
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Ser Ala Ser Ser Glu Glu Asn Val Lys Tyr Ser Ser Ser Gln Pro Glu
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Pro Arg Thr Gly Leu Ser Leu Trp Asp Thr Ser Pro Ser Tyr Ile Asp
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Lys Leu Val Gln Gly Ile Ser Phe Ser Gln Pro Thr Cys Pro Asp His
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Met Leu Leu Asn Ser Gln Leu Leu Gly Thr Pro Gly Ser Ser Gln Asn
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Pro Trp Gln Arg Leu Val Lys Arg Met Thr Arg Phe Phe Thr Lys Leu
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Asp Ala Asp Lys Ser Tyr Gln Cys Leu Lys Glu Thr Cys Glu Lys Leu
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Gly Tyr Gln Trp Lys Lys Ser Cys Met Asn Gln Val Thr Ile Ser Thr
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Thr Asp Arg Arg Asn Asn Lys Leu Ile Phe Lys Val Asn Leu Leu Glu
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Met Asp Asp Lys Ile Leu Val Asp Phe Arg Leu Ser Lys Gly Asp Gly
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